HIWRAP Radar Development for High-Altitude Operation on the NASA Global Hawk and ER-2

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The NASA High-Altitude Imaging Wind and Rain Airborne Profiler (HIWRAP) is a solid-state transmitter-based, dual-frequency (Ka- and Ku-band), dual-beam (30^o and 40^o incidence angle), conical scan Doppler radar system, designed for operation on the NASA high-altitude (20 km) aircrafts, such as the Global Hawk Unmanned Aerial System (UAS). Supported by the NASA Instrument Incubator Program (IIP), HIWRAP was developed to provide high spatial and temporal resolution 3D wind and reflectivity data for the research of tropical cyclone and severe storms. With the simultaneous measurements at both Ku- and Ka-band two different incidence angles, HIWRAP is capable of imaging Doppler winds and volume backscattering from clouds and precipitation associated with tropical storms. In addition, HIWRAP is able to obtain ocean surface backscatter measurements for surface wind retrieval using an approach similar to QuikScat.

There are three key technology advances for HIWRAP. Firstly, a compact dual-frequency, dual-beam conical scan antenna system was designed to fit the tight size and weight constraints of the aircraft platform. Secondly, The use of solid state transmitters along with a novel transmit waveform and pulse compression scheme has resulted in a system with improved performance to size, weight, and power ratios compared to typical tube based Doppler radars currently in use for clouds and precipitation measurements. Tube based radars require high voltage power supply and pressurization of the transmitter and radar front end that complicates system design and implementation. Solid state technology also significantly improves system reliability. Finally, HIWRAP technology advances also include the development of a high-speed digital receiver and processor to handle the complex receiving pulse sequences and high data rates resulting from multi receiver channels and conical scanning.

This paper describes HIWRAP technology development for dual-frequency operation at high-altitudes using low peak power transmitters and pulse compression. The hardware will be described along with the methods and concepts for the system design. Finally, we will present recent preliminary results from flights on the NASA Global Hawk in support of the NASA Genesis and Rapid Intensification Processes (GRIP) field campaign, and on the NASA ER-2 as fixed nadir pointing mode for the NASA Global Precipitation Measurement (GPM) ground validation (GV) mission - Midlatitude Continental Convective Cloud Experiment (MC3E)

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